BEST AVAILABLE COPY

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : H04M 11/00	A1	(11) International Publication Number: WO 92/04796 (43) International Publication Date: 19 March 1992 (19.03.92)

(21) International Application Number: PCT/US91/04957

(22) International Filing Date: 15 July 1991 (15.07.91)

(30) Priority data:
577,388 4 September 1990 (04.09.90) US

(71) Applicant: MOTOROLA, INC. [US/US]; 1303 East Algonquin Road, Schaumburg, IL 60196 (US).

(72) Inventor: BREEDEN, Robert, Louis ; 555 S.W. 25th Avenue, Boynton Beach, FL 33435 (US).

(74) Agents: INGRASSIA, Vincent, B. et al.; Motorola, Inc., Intellectual Property Dept., 1500 N.W. 22nd Avenue, Boynton Beach, FL 33426-8753 (US).

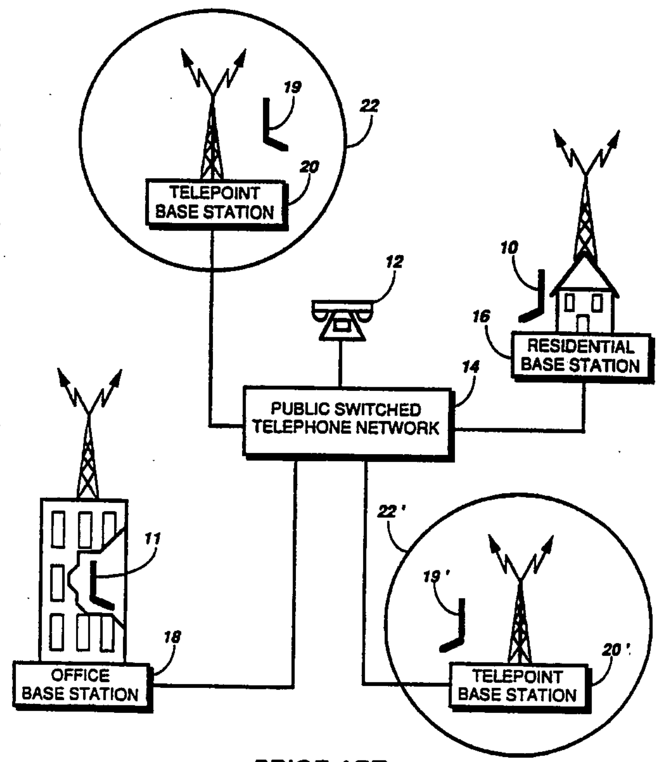
(81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK, DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent).

Published
With international search report.

(54) Title: CORDLESS TELEPHONE SYSTEM FOR RESIDENTIAL, BUSINESS AND PUBLIC TELEPOINT OPERATION

(57) Abstract

A cordless telephone communications system utilizes unlicensed spread spectrum frequency hopping operation for private business (18) and residential (16) service and reuse of frequencies licensed for cellular communications for public telepoint base station (20) service. A cordless telephone (10, 11, 19) capable of both private and public operation scans control channels within the cellular frequency band and, upon locating a predetermined signal broadcast by a public telepoint base station (20) of the cordless telephone communications system, decodes frequency information specifying the frequencies for public operation. The telepoint base station (20) can also broadcast spread spectrum information defining a spread spectrum frequency hopping scheme for public operation.



PRIOR ART

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland			SN	Senegal
CI	Côte d'Ivoire	KR	Republic of Korea	SU+	Soviet Union
CM	Cameroon	LI	Liechtenstein	TD	Chad
CS	Czechoslovakia	LK	Sri Lanka	TG	Togo
DE*	Germany	LU	Luxembourg	US	United States of America
DK	Denmark	MC	Monaco		

+ Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

CORDLESS TELEPHONE SYSTEM FOR RESIDENTIAL, BUSINESS AND PUBLIC TELEPOINT OPERATION

Field of the Invention

This invention relates in general to radio frequency telephone communication systems, and in particular to cordless telephone system operation in residential, business and public environments.

Background of the Invention

The increase in cellular telephone networks has led to an increase in the popularity of cellular telephones and highly portable telecommunications. Yet the large coverage area of cellular networks necessitates high powered operation of cellular telephones (cellular handsets must produce approximately 600 milliwatts output). High power consumption requires a costly handset and costly service to the consumer. High power consumption also limits the size to which a cellular telephone can be reduced. To combat these limitations of cellular telephones, a second generation of cordless telephones (CT-2) utilizing digital telephone technology operating in conjunction with telepoint stations has been developed.

Because of the relatively small size of the telepoint coverage areas, cordless telephones operate at much lower power levels than cellular telephones (approximately 10 milliwatts). Cordless telephones can be built smaller, lighter and cheaper than cellular phones. The cordless telephone technology is older than cellular technology and therefore leads to lower development and manufacturing costs. A cordless telephone can be used with private base stations in controlled environments, such as residential or office settings. In the public arena, a service provider can provide telepoint base

stations for CT-2 communications. A cordless handset can be used within all telepoint coverage areas within a given service area, and thus would approximate the convenience of a cellular telephone with much less cost to the consumer. In addition, though the cost of infrastructure construction can be a substantial investment, using lower-powered telepoint stations which operate relatively independent of each other, results in significantly less cost to the service provider than construction of a cellular network.

Referring to FIG. 1, conventional residential CT-2 operation allows for two way calling between a cordless telephone or CT-2 handset 10 and all telephones 12 hardwired to the public switched telephone network (PSTN) 14 via a residential base station 16. Similarly, conventional business CT-2 systems allow for two-way calling between other handsets 11 on premise and the PSTN 14 via an office base station 18. Away from the home or office base station 16, 18, the user initiates a telephone call by establishing an RF link between another handset 19 or 19' and a telepoint base station 20 or 20' coupled to the PSTN 14. The telepoint stations 20 and 20' provide cordless communication from the handsets 19 and 19', respectively, within islands of coverage 22 and 22', respectively, each having approximately 150 meter radius of the telepoint station depending upon terrain and man-made objects which could interfere with the signalling. For example, cordless telephone operation within a mall or airport would require location of a telepoint station or stations such that the island(s) of coverage would include the mall or airport building.

Public CT-2 systems utilize approximately forty radio frequency (RF) channels for communication between handsets and the telepoint base station. Conventionally, to originate a call, the cordless telephone would scan the forty channels to find an available channel and then attempt to access the telepoint station. The telepoint

station, likewise, would be scanning the forty available channels for incoming calls from the CT-2 handsets. When the telepoint station detects a call request from a handset, interconnection with the PSTN is provided.

To facilitate development of cordless telephone networks, the Great Britain Department of Trade and Industry has developed and published a Common Air Interface (CAI) Specification which has been adopted by most countries of the world working on cordless telephone development. The CAI spells out all aspects of the communications interface standards to be used for the interworking between second generation cordless telephone apparatus, including public access services. The CAI specifies cordless telephone operation on 40 to 100 kHz wide frequency channels within the frequency band bounded by 864 MHz at the low end and 868 MHz at the high end. In the United States, though, the CAI standard frequency band falls within the Public Safety Trunking frequency band allocated under the Federal Communications Commission (FCC) Part 15 Rules.

The rules and regulations of the FCC requires that radio frequency operation within an allocated frequency band be licensed by the FCC. In the United States, virtually no frequencies below 3 GHz in the RF spectrum are unallocated. Currently no frequency band is allocated for CT-2 cordless telephone usage. To obtain reallocation of a frequency band for cordless telephone communications from the FCC could take several years and require a substantial investment of time and funds for political lobbying and other bureaucratic requirements.

The first generation of cordless telephones--analog cordless telephones--are crowded into only ten analog channels in the United States, therefore reuse of the analog cordless telephone channels would be impractical.

Certain frequency bands under FCC Part 15 Regulations are allocated for unlicensed operation. Unlicensed operation within a frequency band, though, must tolerate

interference from other unlicensed users in the frequency band and must not interfere with any licensed users in the radio frequency (RF) spectrum. Conventional frequency hopping spread spectrum techniques are permitted in certain frequency bands under FCC Part 15 Regulations for unlicensed operation, and would provide a high degree of immunity from causing or receiving interference to or from other single-frequency radio services which may be operating nearby, yet a service provider who provides a CT-2 system utilizing unlicensed RF operation cannot predict the future use of the RF channels adopted. Many communication service providers are reluctant to invest much money in public telepoint stations which would operate in an unlicensed spectrum because of the risk that the spectrum could become overcrowded, chaotic, and ultimately unusable for public telepoint service.

Some cellular providers believe that it would be possible to share their currently allocated cellular frequencies for both cellular use and CT-2 public telepoint use without diminishing cellular capacity. They believe that due to the low power and short distance characteristics of cordless telephone service, a cellular provider who desires also to provide public telepoint stations could reuse selected cellular frequencies which could not be reused locally by the higher power cellular system. Unfortunately, this shared cellular frequencies approach would not work for business or residential cordless telephone systems, due to the inability of the cellular provider to control and coordinate the frequencies of such systems to prevent interference.

Thus, what is needed is a single cordless telephone system which can provide service in all three environments--residential, public telepoint, and business--without requiring the user to have multiple handsets.

Summary of the Invention

There is provided in one form a method for transparent frequency reuse which uses a first frequency for high power RF communications in a first area and a second frequency for the high power RF communication in a second area. The first frequency is reused in the second area for low power RF communications.

In another form there is provided a method for radio frequency communications on a plurality of frequencies by broadcasting information identifying those frequencies on another frequency.

In yet another form there is provided a method for cordless telephone operation comprising the steps of determining whether user selectable controls indicate operating in a first mode of operation or a second mode of operation. In the first mode of operation, cordless telephone operation provides communications on at least one frequency within a first frequency band. In the second mode of operation, cordless telephone operation provides communications on at least one frequency within a second frequency band.

Brief Description of the Drawings

FIG. 1 depicts conventional cordless telephone operation in residential, business and public environments.

FIG. 2 depicts reuse of cellular frequencies for cordless telephone operation according to the preferred embodiment of the present invention.

FIG. 3 is a block diagram of a cordless telephone for operation in residential, business and public environments according to the preferred embodiment of the present invention.

FIGs. 4A and 4B are a flowchart of the operation of the microprocessor of the cordless telephone according to the preferred embodiment of the present invention.

Detailed Description of the Invention

Referring to FIG. 1, a second generation cordless telephone (CT-2) system according to the present invention comprises one or more private base stations 16, 18 for residential or business use which operate on a common non-cellular frequency band. Preferably, the private base stations 16, 18 communicate with the handsets 10 on RF frequencies within the 902-928 MHz frequency band allocated for Industrial, Scientific and Medical usage (the ISM band), which lies just slightly above the 869-894 MHz frequency band used for cellular base station transmission.

A spread spectrum approach utilizing conventional frequency hopping techniques is permitted in the ISM band under FCC Part 15 Regulations. FCC Part 15 spread spectrum operation in the ISM band would be advantageous for the business system 18 without much likelihood of interference from other systems (licensed or unlicensed), due both to the attenuation of the building walls and to the building manager's ability to effect a measure of control of the types of radio systems used within the building. FCC Part 15 spread spectrum operation in the ISM band would work well also for the residential system 16, due to the relatively low density of residential users and would offer an order of magnitude improvement over present analog cordless telephone systems which are crowded into only ten allocated analog channels in the United States.

Accordingly, the private base stations (residential 16 and business 18) utilize conventional frequency hopping schemes for improved unlicensed operation on frequencies in the ISM allocated frequency band.

In accordance with a second aspect of the present invention, approximately forty RF channels comprising licensed cellular frequencies are utilized by each telepoint base station 20 of the present invention for CT-2 communications. The public telepoint base stations 20 of the preferred embodiment of the present invention share cellular frequencies and utilize conventional spread spectrum frequency hopping schemes for reliable unlicensed RF communications in a public environment. Use of the spread spectrum approach in public telepoint operation allows economy of handset design because the same spread spectrum circuits could be used in private operation on unlicensed frequencies and public telepoint operation.

Each public telepoint base station 20 is designed to be programmable by the service provider to hop only among selected cellular frequencies usable for a given location. Further, each public base station 20 would have a call set-up protocol which would inform the handset 10 of the correct set of hopping frequencies to use. The use of the spread spectrum frequency hopping schemes reduces the chance of interference to or from the cellular system users.

Referring to FIG. 2, the scheme of the present invention for transparent cellular frequency reuse is described. To ensure cellular telephone communication coverage of an area, conventionally, a plurality of cellular zones 30a, 30b and 30c are established, each zone operating on different frequencies. All of the zones are typically interconnected through a central cellular network controller, each zone having a control frequency associated therewith for control by the controller. Cellular zones 30a (Z1), 30b (Z2), and 30c (Z3) are adjoining zones which have, respectively, control frequencies A1, A2, and A3. Each of the three cellular zones communicate on communication frequencies B1, B2 and B3, respectively.

When setting up zones for cellular communications, the channels for each cellular zone 30a are allocated such that adjoining zones 30b and 30c do not have the same frequencies for communication or control. Telepoint stations 20a, 20b, and 20c for CT-2 communications operate at less power than cellular transmitters and, accordingly, the island of coverage of each telepoint station 22a, 22b and 22c, is smaller than cellular zones 30a, 30b and 30c. According to the present invention, a system provider of a cellular system wishing to construct a CT-2 system with telepoint operation can designate the approximately forty frequencies for telepoint communications by determining the communication and control frequencies of the adjoining cellular zones and assigning them to the telepoint base station such that the telepoint base station has one control frequency for operation and forty communication channels, none of which are utilized by the cellular zone in which the telepoint station is located or a cellular zone near enough to create interference. In the preferred embodiment of the present invention, each public telepoint base station will continually transmit a predetermined CT-2 identifier, identifying the signal as one transmitted by a CT-2 telepoint base station, followed by frequency information indicating the frequencies to be used for communication therewith and the spread spectrum technique to be used, if any, over the one control frequency assigned thereto. The handsets will use the information broadcast on the control channel to determine the frequencies on which to communicate.

The FCC has allocated a plurality of frequencies for cellular communications. The set of cellular frequencies which would provide the highest degree of interference control is the set used for cellular base station transmission because the base transmitters remain stationary. Therefore, the preferred frequencies for assigning to CT-2 reuse would be the cellular base

station frequencies. Four hundred and sixteen frequencies with a 30 KHZ spacing located between the frequencies bounded by 880 MHZ to 890 MHZ and 891.5 MHZ to 894 MHZ are reserved for cellular base station transmissions on systems provided by the Regional Bell Operating Companies (RBOCs). The RBOCs also have reserved the frequencies bounded by 879.4 MHZ at the low end and 880 MHZ at the high end for cellular base station control channels, wherein the transmitters can communicate with the central network controller. Likewise, non-RBOC cellular service providers have reserved 416 cellular base station transmitting frequencies with a 30 KHZ spacing within the frequencies of 869 to 880 MHZ and 890 to 891.5 MHZ, with control frequencies reserved in the band of 834.4 MHZ to 835 MHZ.

Telepoint base station 20b could be assigned control frequency A2 and forty of the communication frequencies B2 allowing telepoint base station operation in the cellular zone 30a and proximate to the cellular zone 30c. Likewise, telepoint base station 20a would be assigned control frequency A3 and communication frequencies from the frequency channels B3.

As a further example of the operation of the preferred embodiment of the present invention, telepoint base station 20c could be assigned control frequency A1 or A2 and communication frequencies from the frequencies B1 and B2. In a true cellular network, there are a plurality of zones and the particular method for reassigning cellular frequencies for CT-2 public telepoint station operation could be expanded to a multiple of telepoint stations within one cellular zone or even a telepoint base station located within two or more cellular zones.

Since the cellular frequencies have been reserved by the FCC for use by the service provider within a predetermined geographic region, the same service provider can provide CT-2 telepoint communications

without the time and expense of requesting new FCC frequency allocation and without fear of future interference from an FCC licensed user. Furthermore, the use of conventional spread spectrum frequency hopping techniques according to the preferred embodiment of the present invention provides decreased probability of interference from or with cellular communications while allowing economy of handset design. The same spread spectrum circuits could be used in the handset to provide for unlicensed operation in the 902-928 MHz ISM band during residential and/or business operation and public operation on cellular frequencies in the 869-894 MHz cellular base station transmission band, which lies just below the ISM band.

Referring next to FIG. 3, a CT-2 handset according to the present invention comprises an antenna 100 coupled to a transmitter circuit 102 and a receiver circuit 104. The microprocessor controller 108 receives a signal from the receiver circuit 104 indicating the received signal strength (the RSSI signal). A time division duplexer 106 controls the signal provided to the transmitter 102 and received from the receiver 104 to facilitate two-way communications by alternately transmitting and receiving on the same channel at a high rate. The operation of the timed division duplexer 106 is controlled by a signal from the microprocessor controller 108.

The microprocessor controller 108 provides a signal to a frequency synthesizer 110 for controlling the operation thereof. The frequency synthesizer 110 supplies the operating channel information to the transmitter 102 and the receiver 104 for modulation and demodulation of the communication signal. In the preferred embodiment of the present invention, the microprocessor controller 108 signals the frequency synthesizer in a manner to provide spread spectrum communications, i.e., instructs the frequency synthesizer

110 to hop between a plurality of frequencies in a predetermined manner.

A public/private switch 112 allows the handset user to indicate the environment of use. During operation, the only action required of the handset user in order to select operation on either a public telepoint system or a private system would be the selection of either the "PUBLIC" or the "PRIVATE" setting of the switch 112. In a business or residential use, the switch 112 is placed in the private mode. The microprocessor controller 108 signals the frequency synthesizer to frequency hop among a predetermined set of frequencies assigned to the residential base station 16 or the office base station 18 (FIG. 1) in a predetermined manner. In the preferred embodiment of the present invention, the frequencies assigned to the residential base station 16 and the office base station 18 and synthesized by the frequency synthesizer 110 are predetermined frequencies in the ISM frequency band (902 to 928 MHZ) which is just above the cellular base transmitting bands. When the switch 112 is in the public mode, the microprocessor controller 108 instructs the frequency synthesizer 110 to synthesize frequencies identified by a signal received on a control channel in the manner discussed below. Conventional CT-2 handsets comprise user selectable public and private controls performing the same function as switch 112 to accommodate the slightly different call set-up procedures on public and private systems and to prevent inadvertent use of a nearby public telepoint system by a user intending to place a call via his residential or business base unit.

The signal received by the receiver 104 or transmitted by the transmitter circuit 102 is a digitally encoded signal which passes through an adaptive differential pulse code modulated codec 114 for digital-to-analog or analog-to-digital conversion. The signal received via the receiver circuit 104 and converted by

the codec 114 is supplied as an analog signal to audio circuitry 116 and thence to a speaker 118. Likewise, an analog signal received from a microphone 120 passes through the audio circuitry 116 and is converted to a digital signal by the adaptive differential pulse code modulated codec 114 before being provided to the transmitter circuit 102.

For other operations, such as dialling up a telephone number, user controls 113 provide appropriate signals to the microprocessor controller 108. In addition, the microprocessor controller 108 supplies a signal to a display driver 122 for generation of a visual message for presentation to the user on a display 124.

Referring next to FIGs. 4A and 4B, the operation of the microprocessor controller 108 (FIG. 3) begins 150 upon energization of the CT-2 handset. If an input interrupt is received 152 from the public/private switch 112 (FIG. 3) processing determines whether the switch 112 is in the public or private position 154. If the switch 112 is in the public position 154, a public mode flag within the microprocessor controller 108 (FIG. 3) is set 156. Alternatively, if the switch 112 is in the private position 154, the public mode flag is cleared 158. Processing then returns to await the next operation.

If an input interrupt is not received 152 from the switch 112, processing determines whether a call has been initiated by the user 160 as indicated by activation of one of the user controls 113 in a conventional manner. If a call has not been initiated 160 and the switch 112 has not provided an input interrupt 152, and the headset is operating in the public mode 162, i.e., the public mode flag is set within the microprocessor 108, processing returns to remain in an idle loop awaiting an input interrupt 152 from the switch 112 or a call initiation signal 160 from the user controls 113.

When operating in the private mode 162, i.e., operating in conjunction with a residential or business

base station, the user can also receive calls. Therefore, when the public mode flag is not set 162 indicating that operation is in the private mode, the signal on the predetermined private channel is sampled 164. To facilitate operation on more than one private base station, the microprocessor controller 108 could store the predetermined frequencies of operation with the various base stations (either predetermined by the manufacturer, programmed by the service provider, or entered via the user controls 113) and the user could indicate which base station he is presently communicating by the user controls 113 (FIG. 3). If sampling the signal 164 does not indicate that a call is received 166 by the handset, processing returns to remain in an idle loop awaiting an input interrupt 152 from the switch 112, a call initiated by the user 160, or a call received for the user 166.

If a call is received for the user as indicated by the signal sample 164, a radio frequency link is established with the private base station 168 in a conventional manner. In accordance with the present invention, the private base station will be assigned a plurality of frequencies within the ISM frequency band and a predetermined frequency hopping scheme. Therefore, the step of establishing an RF link 168 with the private base station involves not only loading the proper frequency to the frequency synthesizer, but also loading the frequency synthesizer with the subsequent frequencies at the times indicated by the particular frequency hopping scheme assigned to the private base station.

Once the link is established 168, operation awaits for the call to be completed 170. When the call is completed, operation returns to the idle loop to await the next input interrupt 152, call initiation 160, or call received 166.

If a call is initiated 160, the public mode flag is examined 172 to determine whether the microprocessor 108

is operating in the public mode or the private mode. If private mode operation is indicated 172, an RF link with the private base station is established 174 as described above and completion of the call is awaited 176. Upon completion of the call 176, operation returns to await the input interrupt 152 from the switch 112, a subsequent call initiation 160, or a call received 166.

If examination of the public mode flag 172 indicates public mode operation, a scan timer is set to its maximum value 178. The scan timer sets a maximum time for the CT-2 handset to determine whether it is within range of a public telepoint base station in order to establish an RF link therewith. According to the preferred embodiment of the present invention, the maximum value of the scan timer may be user programmable via the user controls 113. After loading the maximum value of the scan timer 178, the microprocessor controller 108 then loads a first public control channel to the frequency synthesizer 110 and samples the signal thereon 180. If the receive signal strength indicator (the RSSI signal) is not greater than a predetermined threshold 182, the microprocessor 108 loads the next public control channel 184 to the frequency synthesizer 110 and samples the signal on that channel 180. If a sample signal has a receive signal strength indicator greater than a predetermined threshold 182, indicating that the handset is within communication range of a transmitter transmitting that signal, processing determines whether a predetermined CT-2 identifier has been detected 186 in the sample signal. The CT-2 identifier establishes that the transmitter transmitting the signal is a CT-2 telepoint base station. According to the present invention, each public telepoint base station will continually transmit a predetermined CT-2 identifier followed by frequency information indicating the frequencies to be used for communication therewith and the spread spectrum technique to be used, if any. If the

predetermined CT-2 identifier is not detected 186 and the scan timer does not equal zero (i.e., has not timed out) 188, the microprocessor 108 loads the next public control channel 184 to the frequency synthesizer 110 and the signal on that channel is sampled 180.

If the scanned timer times out 188, the microprocessor controller 108 provides appropriate signals to the display driver 122 to generate a message for display on the display 124 indicating to the user that a telephone base station was not located 190. In this manner, when a signal from a telepoint base station is not found on a control channel within the maximum value of the scan timer, the user will be notified 190 and may then go to a location where he has a better chance of initiating a call.

Once the predetermined CT-2 identifier is detected 186, the frequency information transmitted on the CT-2 telepoint control channel is decoded 192. The frequency information, as explained above, indicates the communication frequencies of the telepoint base station and the spread spectrum technique to be used to establish an RF link therewith. After decoding the frequency information 192, the microprocessor controller 108 loads those frequencies to the frequency synthesizer 110 in the identified frequency hopping manner to establish a spread spectrum RF link with the public telepoint base station on the designated frequencies 194. The caller then dials the telephone number via the user controls 113 (FIG. 3) and makes the telephone call. Processing then awaits completion of the call in a conventional manner 196, after which processing will return to await the next input interrupt 152 from the switch 112 or a subsequent call initiation 160.

By now it should be appreciated that there has been provided a cordless telephone communications system which offers service providers the protection of licensed spectrum for their public telepoint service investment on

cellular communications allocated frequencies without diminishing the subscriber capacity of the shared cellular system. In addition, private base stations in the business and residential environments would be able to share spectrum unobtrusively with other users via spread spectrum techniques without the need for licensing, thereby requiring no new frequency bands allocated for use by the cordless telephone communications system.

What is claimed is:

CLAIMS

1. A method for transparent frequency reuse comprising the steps of:

using a first frequency for high power RF communications in a first area;

using a second frequency for said high power RF communications in a second area; and

reusing said first frequency within said second area for low power RF communications.

2. The method according to Claim 1 wherein said high power RF communications is cellular telecommunications.

3. The method according to Claim 1 wherein said low power RF communications is cordless telephone communications.

4. The method according to Claim 1 wherein said second area adjoins said first area

5. The method according to Claim 1 further comprising the step of using a plurality of third frequencies in a plurality of third areas, wherein the step of reusing said first frequency within said second area further comprises the step of reusing said plurality of third frequencies and said first frequency within said second area for said low power RF communications.

6. The method according to Claim 5 wherein said step of reusing said plurality of third frequencies and said first frequency comprises the step of reusing said plurality of third frequencies and said first frequency within said second area for low power RF spread spectrum communications.

7. A transparent frequency reuse system for RF communications comprising:

a wide area RF communications system comprising a plurality of zones and utilizing a plurality of frequencies, each of said plurality of zones utilizing at least one of said plurality of frequencies; and

a telepoint RF communications system having a coverage area located within at least one of said plurality of zones, said telepoint system utilizing a subset of said plurality of frequencies, said subset not comprising said at least one of said plurality of frequencies utilized within said at least one of said plurality of zones by said wide area RF communications system.

8. The system of Claim 7 wherein said wide area RF communications system further utilizes a plurality of control frequencies, each of said plurality of zones utilizing at least one of said plurality of control frequencies, and wherein said telepoint system utilizes one of said plurality of control frequencies not utilized by said at least one of said plurality of zones.

9. The system of Claim 8 wherein said telepoint system comprises first broadcast means for transmitting first information identifying said subset of said plurality of frequencies on said one of said plurality of control frequencies.

10. The system of Claim 8 wherein said telepoint system comprises second broadcast means for transmitting second information identifying a frequency hopping scheme utilized by said telepoint system.

11. A method for RF communications comprising the step of transmitting a first signal on a first frequency, said first signal comprising frequency information identifying a plurality of frequencies to utilize for said cordless telecommunications.

12. The method according to Claim 11 wherein the step of transmitting said first signal comprises the step of transmitting said first signal on said first frequency, said first signal comprising said frequency information and spread spectrum information identifying a frequency hopping scheme utilized for said cordless telecommunications.

13. The method according to Claim 12 wherein said step of transmitting said first signal further comprises the step of transmitting on said first frequency a second signal comprising order information identifying the order for frequency hopping among the plurality of frequencies.

14. A method for RF communications comprising the steps of:

scanning a first group of frequencies to find a signal of sufficient received signal strength;

decoding said signal to obtain frequency information; and

communicating on at least one frequency, said at least one frequency identified by said frequency information.

15. The method according to Claim 14 wherein said step of communicating comprises frequency hopping among a plurality of frequencies, said plurality of frequencies identified by said frequency information

16. The method according to Claim 15 wherein said step of decoding comprises the step of decoding said signal to obtain frequency information and spread spectrum information, said spread spectrum information defining frequency hopping among said plurality of frequencies.

17. A method for cordless telephone operation comprising the steps of:

determining if user selectable controls indicate operation in a first mode of operation or a second mode of operation;

communicating on at least one frequency in a first frequency band if said user selectable controls indicate operation in said first mode of operation; and

communicating on at least one frequency within a second frequency band if said user selectable controls indicate operation in said second mode of operation.

18. The method according to Claim 17 further comprising the steps of:

scanning a plurality of predetermined control frequencies if said user selectable controls indicate operation in said second mode of operation;

determining if a signal on one of said plurality of control frequencies scanned comprises a predetermined signal; and

receiving and decoding said signal on said one of said plurality of control frequencies to derive frequency information if said signal comprises said predetermined signal; and

wherein said step of communicating on said at least one frequency within said second frequency band comprises the steps of:

designating said at least one frequency in response to said decoded frequency information; and

communicating on said at least one frequency.

19. A cordless telephone comprising:

user selectable means for selecting either a public mode of operation or a private mode of operation;

transceiver means for communicating with a base station, said transceiver means comprising receiver means for receiving and decoding signals;

frequency synthesizing means for generating a plurality of frequencies for communicating with said base station, said plurality of frequencies comprising a first plurality of frequencies within a first frequency band for cordless telephone operation in said private mode of operation and a second plurality of frequencies within a second frequency band for cordless telephone operation in said public mode of operation;

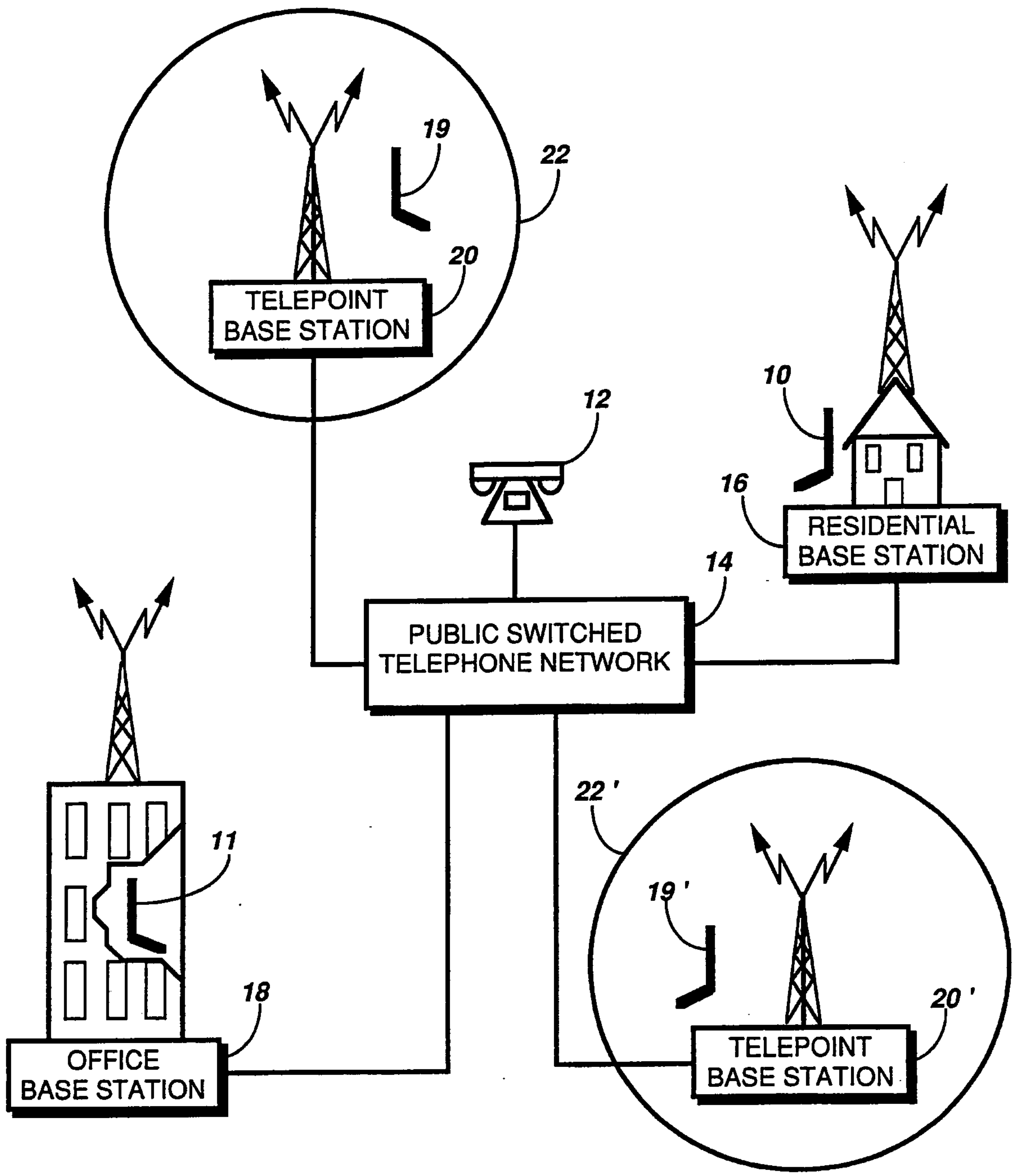
scanning control means for scanning a plurality of control frequencies in said public mode of operation; and

control means for identifying at least one of said second plurality of frequencies within said second frequency band in said public mode of operation, said at least one of said second plurality of frequencies determined by frequency information decoded by said receiver means on one of said plurality of control frequencies having a predetermined signal transmitted thereon.

20. The cordless telephone of Claim 19 wherein said transceiver means comprises receiver means for receiving signals having a received signal strength, the cordless telephone further comprising:

signal strength measuring means coupled to said receiving means for measuring the received signal strength of said signals received on each of said scanned control frequencies; and wherein

said control means identifies said at least one of said second plurality of frequencies by said frequency information decoded by said receiver means on one of said plurality of control frequencies having the measured received signal strength greater than a predetermined threshold value.



PRIOR ART

FIG. 1

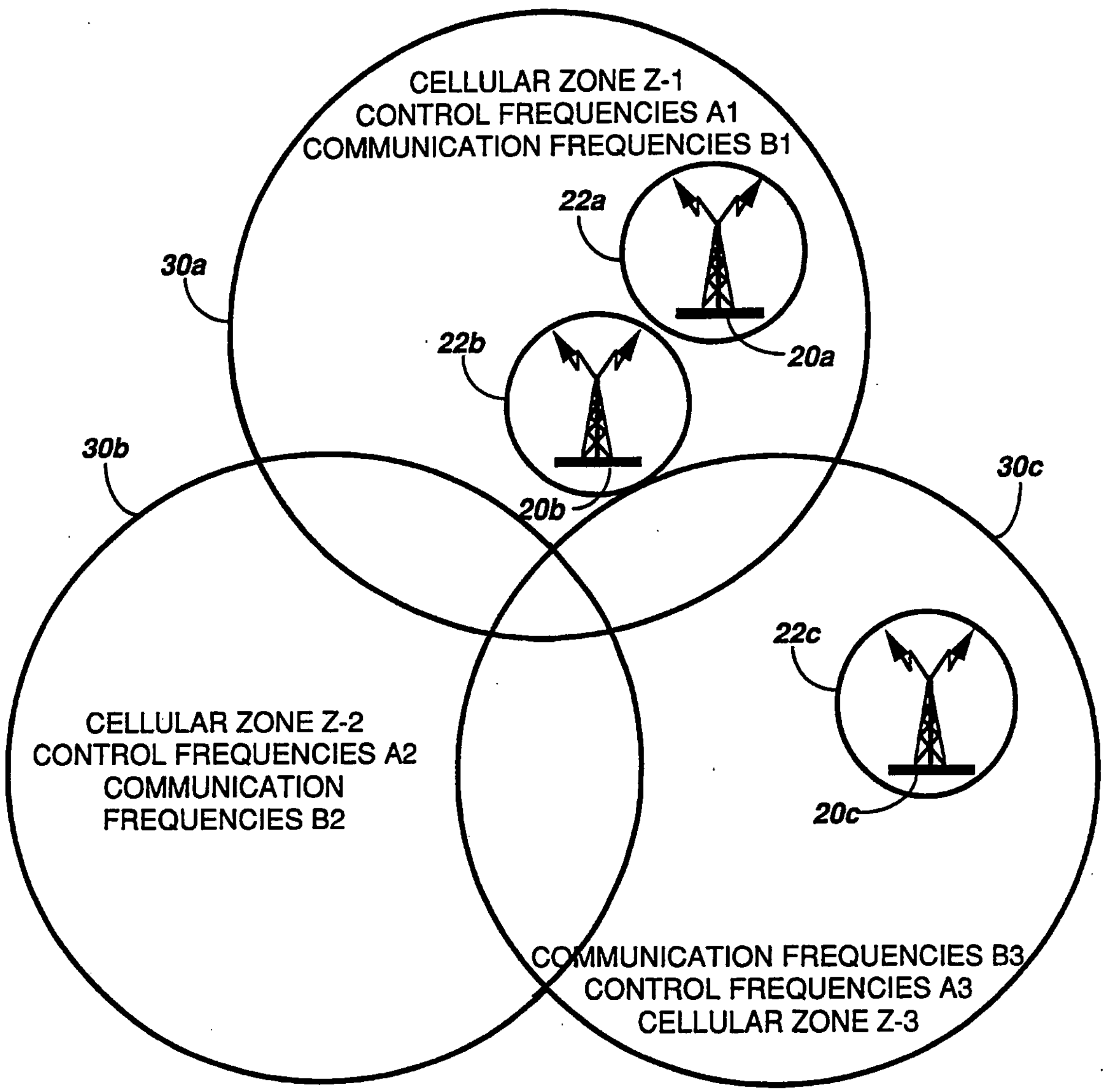

CELLULAR ZONE Z-1
CONTROL FREQUENCIES A1
COMMUNICATION FREQUENCIES B1
22a
30a
22b
20a
30b
20b
30c
22c
CELLULAR ZONE Z-2
CONTROL FREQUENCIES A2
COMMUNICATION
FREQUENCIES B2
20c
COMMUNICATION FREQUENCIES B3
CONTROL FREQUENCIES A3
CELLULAR ZONE Z-3

FIG. 2

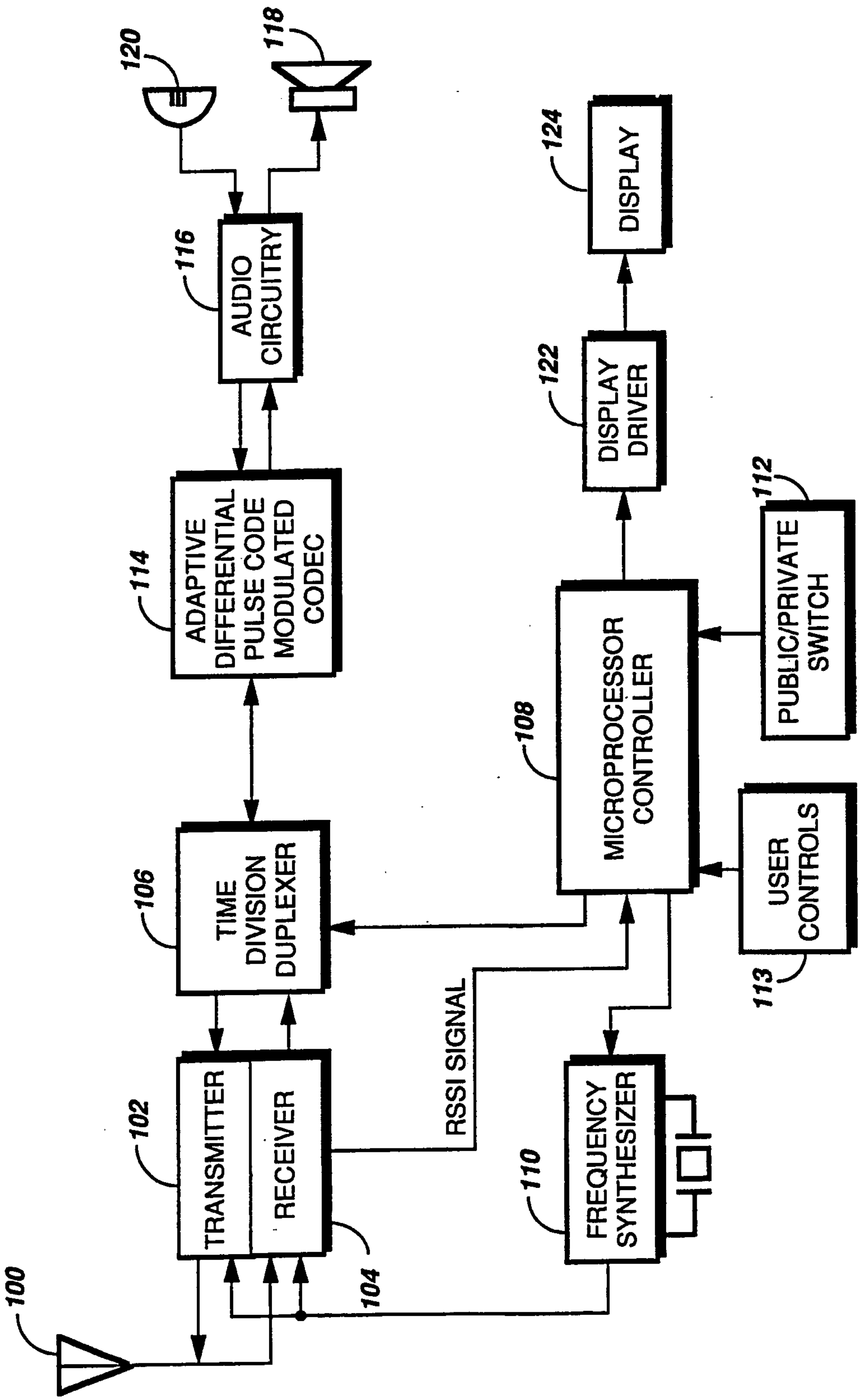

100
TRANSMITTER
RECEIVER
102
104
TIME DIVISION DUPLEXER
106
ADAPTIVE DIFFERENTIAL PULSE CODE MODULATED CODEC
114
AUDIO CIRCUITRY
116
120
118
RSSI SIGNAL
MICROPROCESSOR CONTROLLER
108
FREQUENCY SYNTHESIZER
110
USER CONTROLS
113
PUBLIC/PRIVATE SWITCH
112
DISPLAY DRIVER
122
DISPLAY
124

FIG. 3

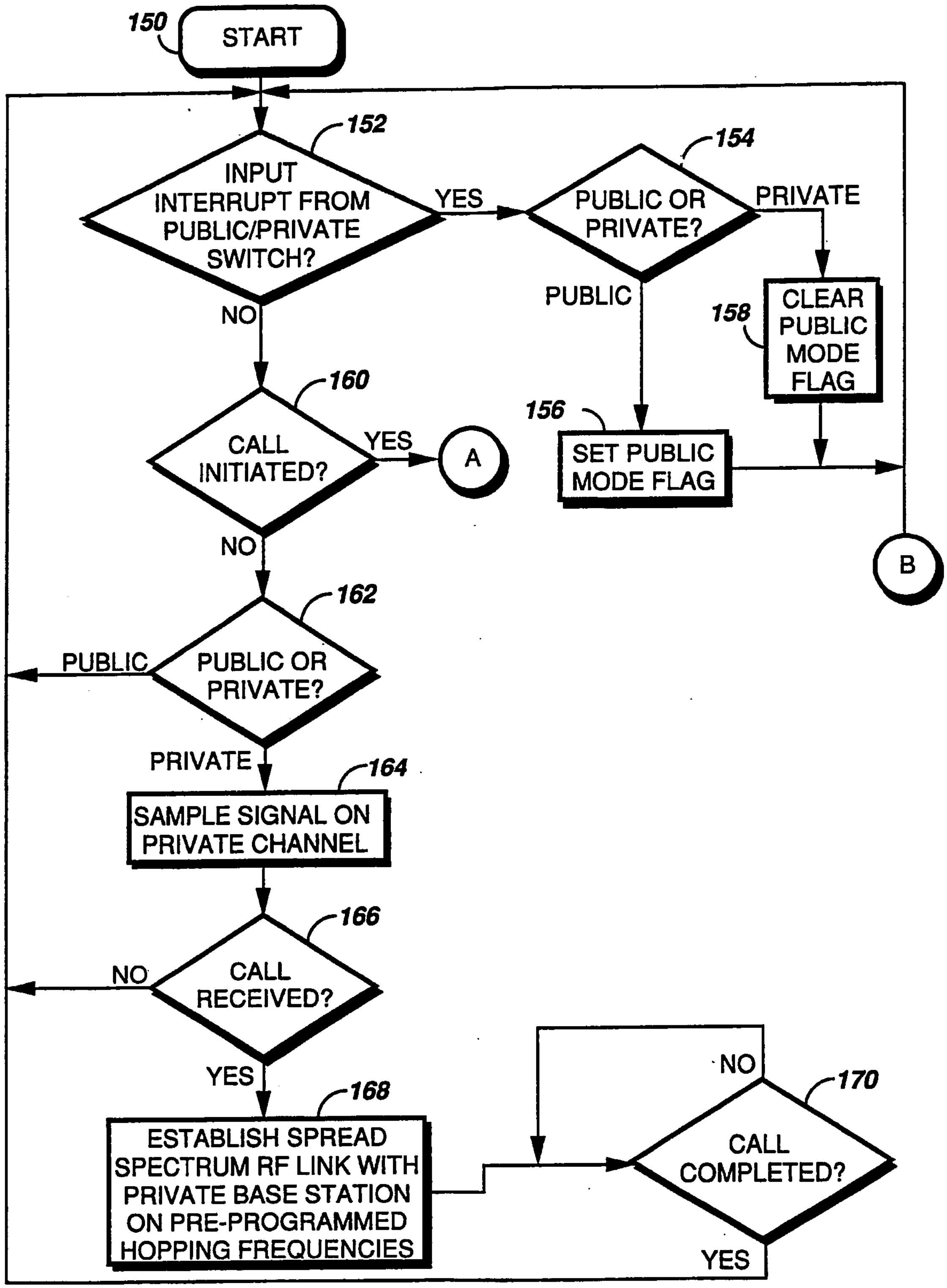

150
START
152
INPUT INTERRUPT FROM PUBLIC/PRIVATE SWITCH?
YES
NO
154
PUBLIC OR PRIVATE?
PRIVATE
PUBLIC
158
CLEAR PUBLIC MODE FLAG
156
SET PUBLIC MODE FLAG
160
CALL INITIATED?
YES
A
NO
B
162
PUBLIC
PUBLIC OR PRIVATE?
PRIVATE
164
SAMPLE SIGNAL ON PRIVATE CHANNEL
166
NO
CALL RECEIVED?
YES
168
ESTABLISH SPREAD SPECTRUM RF LINK WITH PRIVATE BASE STATION ON PRE-PROGRAMMED HOPPING FREQUENCIES
NO
170
CALL COMPLETED?
YES

FIG. 4A

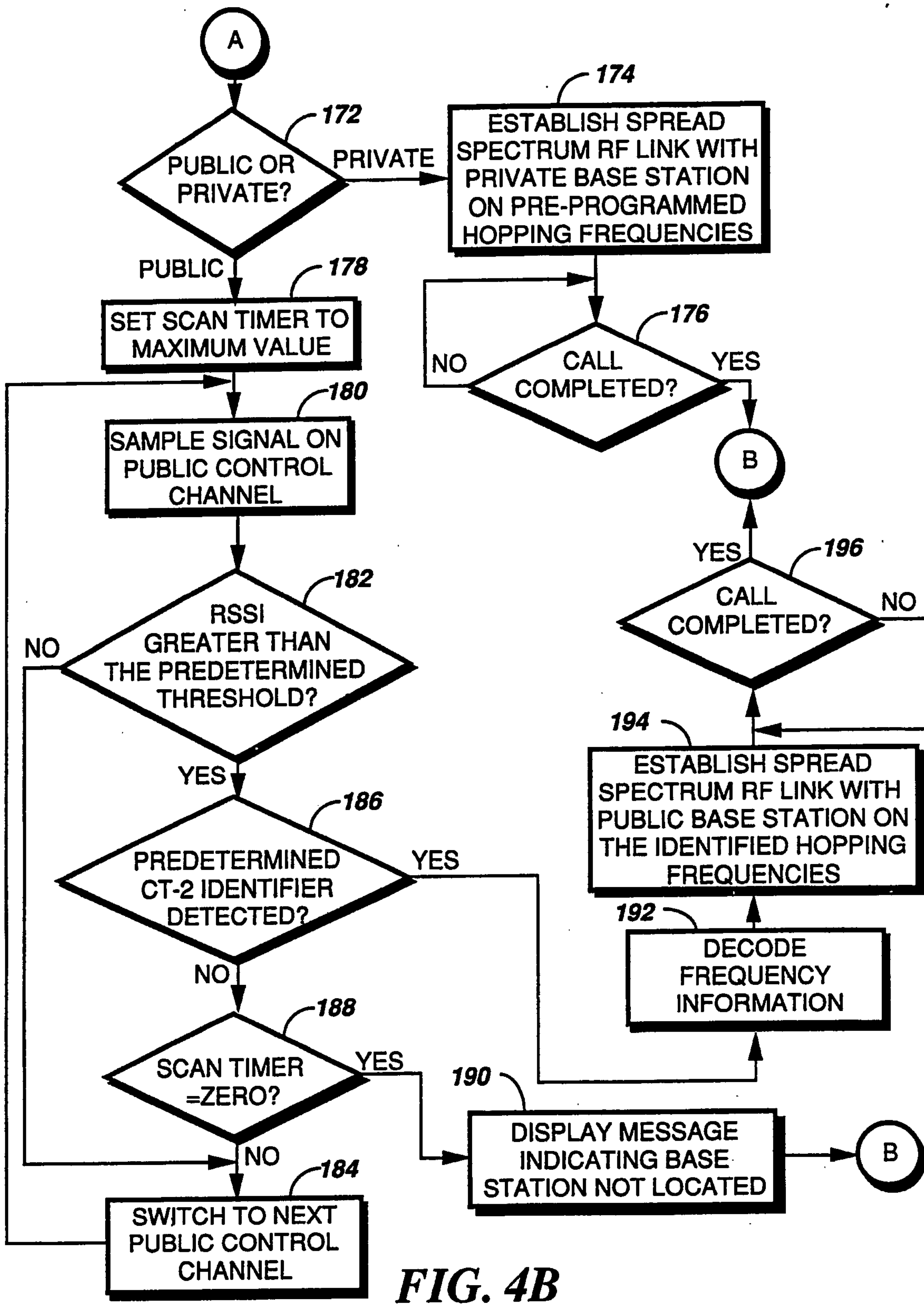

A
172
PUBLIC OR PRIVATE?
PRIVATE
174
ESTABLISH SPREAD SPECTRUM RF LINK WITH PRIVATE BASE STATION ON PRE-PROGRAMMED HOPPING FREQUENCIES
PUBLIC
178
SET SCAN TIMER TO MAXIMUM VALUE
176
CALL COMPLETED?
NO
YES
180
SAMPLE SIGNAL ON PUBLIC CONTROL CHANNEL
B
YES
196
CALL COMPLETED?
NO
182
RSSI GREATER THAN THE PREDETERMINED THRESHOLD?
NO
194
ESTABLISH SPREAD SPECTRUM RF LINK WITH PUBLIC BASE STATION ON THE IDENTIFIED HOPPING FREQUENCIES
YES
186
PREDETERMINED CT-2 IDENTIFIER DETECTED?
YES
192
DECODE FREQUENCY INFORMATION
NO
188
SCAN TIMER =ZERO?
YES
190
DISPLAY MESSAGE INDICATING BASE STATION NOT LOCATED
B
NO
184
SWITCH TO NEXT PUBLIC CONTROL CHANNEL

FIG. 4B

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/04957

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5); H04M 11/00
US. CL. 379/59,61

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	379/58-63; 455/67

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X / Y	US, A, 4,790,000(KINOSHITA) 06 DECEMBER 1988 See abstract; figures 1,2, and 5; column 1, lines 44-48, line 65 to column 2, line 4; column 3, lines 12-24; column 4, lines 41-45.	1-3,5-8 / 4,9,10
X,P / Y	US, A, 4,989,230 (GILLIG ET AL.) 29 JANUARY 1991 See abstract; figures 1 and 2; column 5, lines 12-16.	17,19 / 18,20
Y	US, A, 4,878,238 (RASH ET AL.) 31 OCTOBER 1989 See abstract; column 9, lines 35-37.	20
X,P / Y	US, A, 5,020,130 (GRUBE ET AL.) 28 MAY 1991 See column 1, lines 13-23; column 2, lines 53-62.	11 / 12,13
Y	US, A, 4,866,710 (SCHAEFFER) 12 SEPTEMBER 1989 See column 3, lines 60-65; column 4, lines 16-30.	12,13
A	IEEE Communications Magazine "Communications and the Law", by Newman, Jr., July 1986, vol. 24, no. 7, pages 46-47.	

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
04 NOVEMBER 1991	13 DEC 1991
International Searching Authority	**Signature of Authorized Officer**
ISA/US	DUAYNE BOST

Form PCT/ISA/210 (second sheet) (Rev.11-87)

International Application No. PCT/US91/04957

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	IEEE Communications Magazine "Spread Spectrum for Indoor Digital Radio", by Kavenrad et. al., June 1987, vol. 25, no. 6, pages 32-39.	
X	US, A, 4,860,337 (SHIMURA) 22 AUGUST 1989 See column 1, lines 32-41.	11

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers , because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers .., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

3. ☐ Claim numbers__________, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

I. Claims 1-13,17-20 are drawn to a system, method, and apparatus for reusing-frequencies in a cellular environment; class 379, subclass 59.

II. Claims 14-16 are drawn to a method for radio frequency communications class 455, subclass 161. (See supplemental sheet 1

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers: 1-13,17-20 (Telephone Practice)

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

International Application No. PCT/US91/04957

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
	REASONS FOR HOLDING LACK OF UNITY OF INVENTION: Group II (claims 14-16) is drawn to a method for RF communications and does not provide any limitations which would tend to implement the invention set forth in these claims, within a cellular telephone environment of Group I.	